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A STUDY OF LYNDS 1251 DARK CLOUD: II. INFRARED PROPERTIES

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ABSTRACT

We have studied the star forming activities and dust properties of Lynds 1251, a dark cloud located at relatively high galactic latitude. Eleven IRAS point sources identified toward Lynds 1251 are discussed. Estimate of stellar masses, and far-infrared lumnosities of the young stars associated with two prominent IRAS point sources imply that these are T-Tauri stars with masses smaller than 0.3 $M_{\odot}$. The low dust temperature of 27 K and low ratio of FIR emission to hydrogen column density are probably due to the lack of internal heating sources. Presumably two low mass young stars do not have enough energy to heat up the dust and gas associated. The dust heating is dominated by the interstellar heating source, and the weaker interstellar radiation field can explain the exceptionally low dust temperatures found in Lynds 1251. The estimated dust mass of Lynds 1251 is just ~ 1 $M_{\odot}$, or about 1/1000 of gas mass, which implies that there must be a substantial amount of colder dust. The infrared flux at 100 μmis matching well with ^{13}CO peak temperature, while the ^{12}CO integrated intensity is matching with the boundary of dust emission. Overall, the dust properties of Lynds 1251 is similar to those of normal dark clouds even though it does have star forming activities.

Key Words : Dark Cloud, Lynds 1251, Infrared Properties

I. INTRODUCTION

A small elongated dark cloud Lynds 1251, known as part of 'Cepheus Flare' (Grenier *et al.*1989), has been investigated in molecular lines by several authors, including recent study by Lee (1994; hereafter Paper I). In Paper I we found that two bipolar outflows within Lynds 1251 do not affect the dynamics of the cloud significantly, and that the cloud is very quiescent. As the two bipolar outflows are known to be the only heating sources in Lynds 1251, their interaction with surrounding medium as well as dust properties of presumably unheated region can be investigated in more detail through their infrared properties. However, only the limited region of Lynds 1251 have partially studied in near infrared (Hodapp 1994) and the dust properties of the cloud have not been investigated.

It is believed that dust comprises just a small fraction ($\sim$ 1%) by mass of the interstellar medium in the Galaxy. However, the dust is very effective at absorbing starlight and reemitting this energy at much longer wavelengths, mostly in the far-infrared (FIR). Thus, the information on embedded stars as well as properties of the dust can be extracted from the FIR emission. While giant molecular clouds (GMCs) are usually associated with strong FIR emission and massive star forming activities, normal dark clouds are not usually strong sources of FIR emission and no massive star forming activity is found. FIR emission associated with Lynds 1251 in this work, in fact, is much weaker than found in GMCs.

In this paper we study more thoroughly infrared properties of Lynds 1251. We analyze both the extended FIR emission as well as point sources detected by the Infrared Astronomy Satellite (IRAS) toward Lynds 1251. The correlation between dust emission and carbon monoxide is described in detail, and IRAS point sources are investigated extensively including two prominent sources which are associated with dense clumps (Paper I).

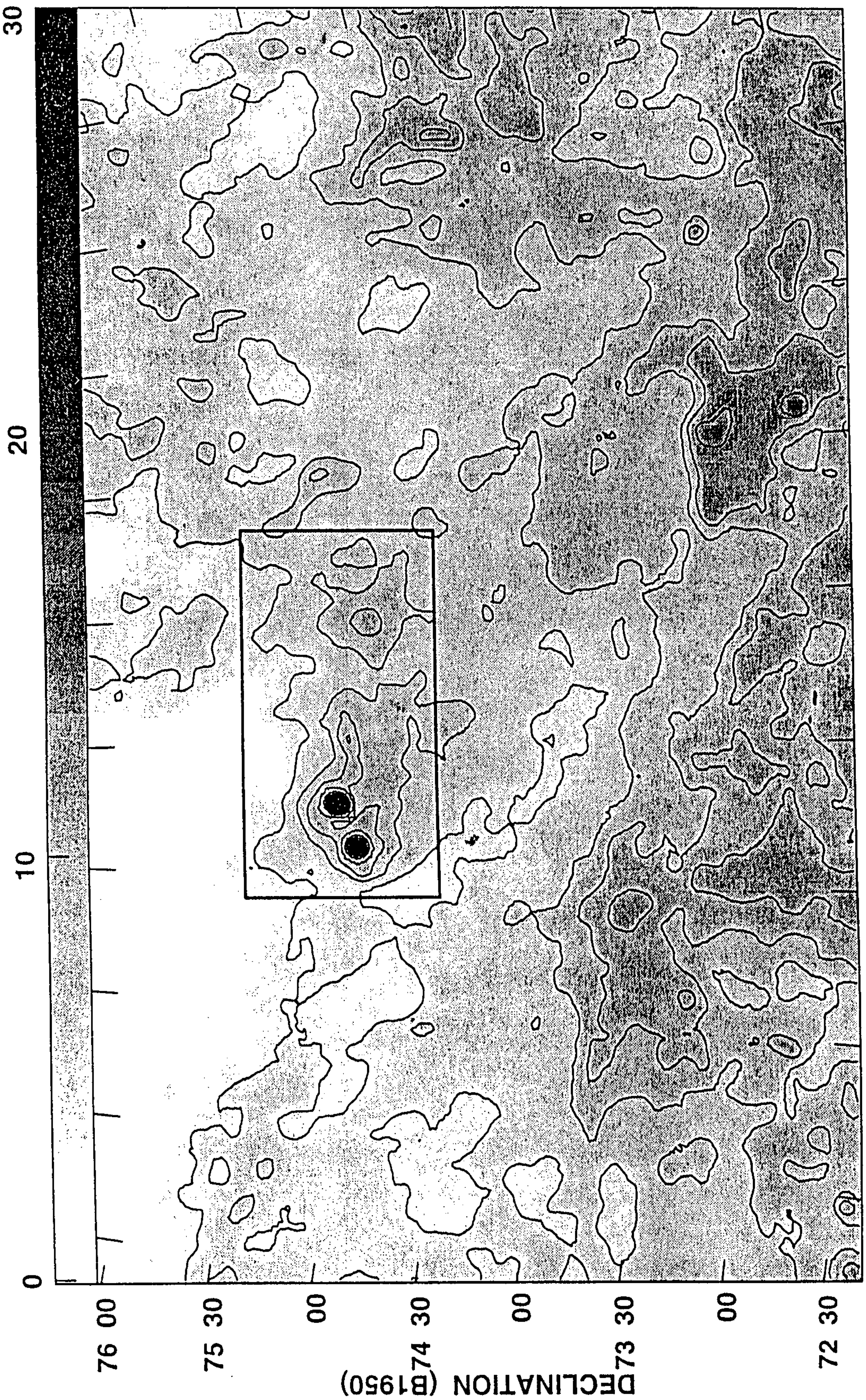

Fig. 1. The 100 μm ISSA image of an $6^\circ \times 4^\circ$ region centered on Lynds 1251. The location of Lynds 1251 is marked with the solid box. The lowest contour level and the increment between levels are 2.7 MJy/sr. The grey scale is ranging from 0 to 30 MJy/sr.

II. INFRARED DATA

We have acquired 6° × 4° ISSA (*IRAS Sky Survey Atlas)* images in 100 μmIRAS band centered on the position of Lynds 1251 from IPAC (*Infrared Processing and Analysis Center*) and it is presented in Figure 1. The region mapped in CO $J = 1 - 0$ is marked with the solid line (see Paper I). It is remarkable that Lynds 1251 is almost free of contamination from other sources as presented in Figure 1, and the emission corresponds well with the map of the CO integrated intensity of the cloud (see Paper I). Brighter dust emission is degrees away from the cloud. Two bright sources inside the solid box are prominent, which are associated with two outflow sources (Sato and Fukui 1989; and Sato *et al.*1994).

We have also obtained ISSA images in other three IRAS bands (12, 25, and 60 μm) centered on Lynds 1251. Images only within the box in Figure 1 were extracted at all four bands to study the extended emission from the dust. In Figure 2, color images instead of raw images of three bands are presented; (I_{60}/I_{100}, I_{25}/I_{100}, and I_{12}/I_{100}). Hot IRAS sources can be represented much better in the color images than in the raw images.

To investigate possible embedded stellar objects, all sources in the *IRAS Point Source Catalogue* (1988) within the region mapped in ^{12}CO (Paper I) were obtained. However, we did not impose any criteria on these point sources to insure possible stellar objects, as there are only small number of sources within the cloud boundary. We include all th point sources listed in *IRAS Point Source Catalogue.* Eleven sources are found and are listed in Table 1. The table includes the IRAS point source names, equatorial coordinates, and flux densities at the four IRAS wavelength bands. The last column will be discussed in later section. The locations of these sources are marked in Figure 3, along with an outline of the CO emission (4.5 K km s^{-1} of CO integrated intensity: see Paper I). Two asterisk signs represent late-type stars, and filled circles are the sources associated with outflows. The open circles are generally weak FIR sources.

Table 1. FIR flux densities and luminosities of IRAS point sources

Name	α	δ	S_{12}	S_{25}	S_{60}	S_{100}	$L_{FIR}[L_{\odot}]$
22148+7508	$22^h14^m52.7^s$	$+75°8^m29^s$	0.24	0.25	0.40	8.35	0.33
22219+7445	$22^h21^m57.9^s$	$+74°45^m0^s$	0.24	0.25	0.40	7.62	0.31
22290+7458	$22^h29^m3.3^s$	$+74°58^m51^s$	0.28	0.38	0.73	9.09	0.38
22343+7501	$22^h34^m22.0^s$	$+75°1^m32^s$	4.97	26.08	66.34	80.04	8.90
22350+7502	$22^h35^m3.6^s$	$+75°2^m59^s$	0.36	0.65	0.40	80.04	2.90
22355+7505	$22^h35^m32.6^s$	$+75°5^m55^s$	0.25	0.24	0.40	6.91	0.28
22361+7506	$22^h36^m9.6^s$	$+75°6^m39^s$	9.17	2.17	0.40	4.59	0.20
22376+7455	$22^h37^m40.8^s$	$+74°55^m50^s$	0.80	5.55	32.34	66.84	5.32
22385+7457	$22^h38^m34.1^s$	$+74°57^m53^s$	0.35	0.31	0.40	6.24	0.26
22397+7454	$22^h39^m45.1^s$	$+74°54^m15^s$	0.33	0.23	2.33	6.24	0.43
22398+7448	$22^h39^m49.7^s$	$+74°48^m12^s$	0.25	0.20	1.34	6.24	0.34

III. DATA ANALYSIS

(a) IRAS Point Sources

The 11 IRAS point sources are located somewhat randomly throughout the cloud and not concentrated toward the regions of strong ^{12}CO emission except two outflow sources. If we assume these 11 sources to be associated with Lynds 1251, their FIR luminosities can be estimated for each of these sources. The FIR luminosities of the point sources can be obtained by summing the luminosities in 12, 25, 60, and 100 μmbands, if the emission in each band is not blended with neighboring sources. Another usual method to estimate FIR luminosities is using Lonsdales *et al.*(1985)'s definition;

$$L_{FIR} = 4\pi d^2 R[1.26(1.00 \times 10^{12} S_{100} + 2.58 \times 10^{12} S_{60})],$$

where S_ν is the flux density at IRAS band ν, d is the distance to the object, and R is the color correction factor (see Paper I). Contrary to Paper I, we did not introduce color correction factors (i.e., the flux densities assume an underlying energy distribution $S_\nu \propto \nu^{-1}$), as the color correction is not possible for the less bright sources. This assumption is not always correct for the point sources, but the color-corrected contribution would not be serious (~ 30%) in estimating FIR luminosities. Luminosities are obtained assuming that the distance of IRAS point sources is 300 pc (Kun and Prusti 1993); FIR luminosities are presented at the last columns in Table 1.

A color-color diagram, log (S_{60}/S_{25}) vs. log (S_{25}/S_{12}) for all of the IRAS sources are presented in Figure 4. This diagram provides a valuable method of classifying IRAS point sources (Harris, Clegg & Hughes 1988; Beichman *et al.*1986; and Carpenter *et al.*1993). The filled circles are the IRAS point sources seen toward two bipolar outflows of Lynds 1251, and the asterisks are two late-type stars. Open circles are weak sources comparing with other point sources. The location of the embedded core sources (solid-outlined box) in the color-color diagram is indicated (Emerson 1985). The dashed-outlined box presents the location on which 90% of K-type stars are residing (Lee 1996). The two IRAS point sources, 22343+7501 and 22376+7455, are located in the head part of the cloud (see Paper I). The K' band (2.11 μm) images were obtained from Hodapp's (1994) Catalog and shown in Figure 5. The molecular outflow position at IRAS 22343+7501 is marked by a group of three stars associated with a nebulosity of approximately bipolar morphology (Figure 5a). A more detailed study of these sources based on optical CCD images has been presented by Balázs *et al.*(1992). According to Hodapp (1994), the driving source of the outflow is probably one of those three stars. A fainter star to the south of this nebula is also associated with a localized reflection nebula. A small group of stars is clearly visible at the IRAS 22376+7455 position (Figure 5b). Three of these stars are associated individually with localized reflection nebula. Fainter nebulosity surrounds the other stars in this group as well.

(b) Extended Emission

i) Correlation with CO Emission

The relationship between the dust emission in the infrared and the column density of CO in interstellar clouds deserves more study as both of the CO emission and the infrared emission from dust should be useful tracers of the distribution of mass within molecular clouds. Both of infrared continuum emission from dust and CO spectral line emission can be used to estimate the mass of interstellar clouds, and the FIR data can be compared for consistency and/or calibration with CO data. In fact, spatial coincidence and close morphological similarity is found between the CO emission for isolated clouds and their dust emission, especially after subtraction of the extended Galactic FIR emission (Heyer *et al.*1987; Langer *et al.*1989; and Mooney 1992). An accurate separation of the Galactic background FIR emission from the cloud emission is necessary to use the IRAS data to estimate the FIR luminosity of the cloud accurately. However, for the case of Lynds 1251 the identification of the FIR emission is straightforward as the cloud is well isolated.

A good correlation is found between the FIR emission and the ^{12}CO integrated intensity (Figure 6a). Pixels with ^{12}CO integrated intensity above 2 K km s^{-1} have been fit by least-squares to determine the relation between ^{12}CO integrated intensity and FIR flux (the pixels with $I_{100} > 10$ MJy/sr are not included as these are from the two outflows), the equation of the fitted line is given below and illustrated in Figure 6a:

$$I_{100} = 0.47(\pm 0.04) I_{^{12}CO} + 0.99(\pm 0.21)$$

The non-zero intercept value most likely represents emission from dust of the region which is lack of ^{12}CO emission. The amount of dust that lies in front of or behind Lynds 1251, thus unassociated with the cloud, may be very small as the intercept of Equation (2) is negligible. The slope represents the true relation between ^{12}CO integrated intensity and FIR intensity. The slope between the FIR emission and ^{12}CO emission associated with the outflow sources is much larger than that of the whole portion of the cloud. This is not surprising, since the warm dust associated with the sources should produce more emission per unit column density.

A good correlation is also found between the FIR emission and the ^{13}CO integrated intensity (Figure 6b). Pixels with ^{13}CO integrated intensity have been fit the same way as above to determine the relation between ^{13}CO integrated intensity and FIR flux, the equation of the fitted line is given below and illustrated in Figure 6b:

$$I_{100} = 1.67(\pm 0.02) I_{^{13}CO} + 2.34(\pm 0.11)$$

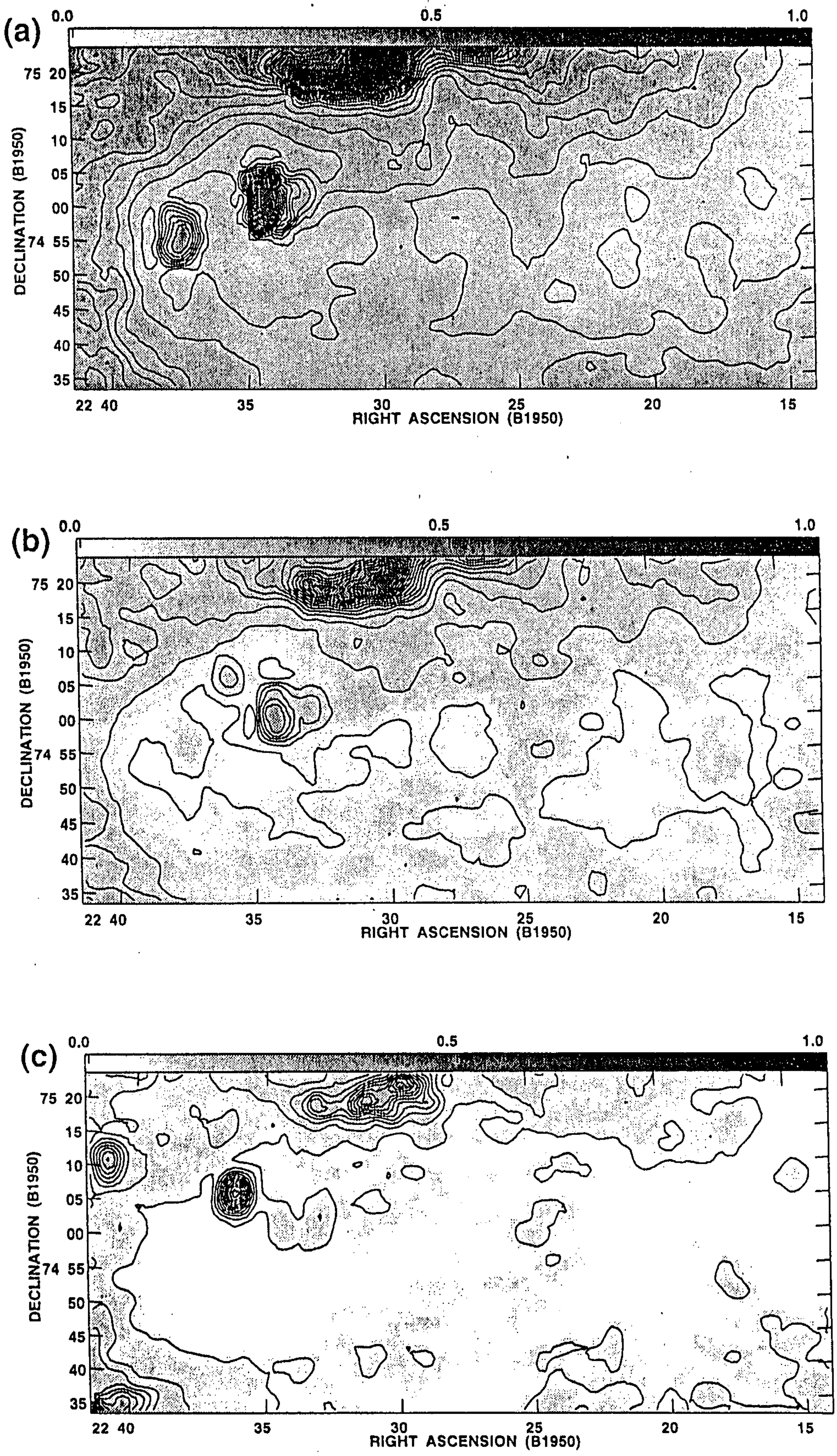

Fig. 2. Infrared color images of Lynds 1251; (a) I_{60}/I_{100} (b) I_{25}/I_{100} (c) I_{12}/I_{100}. The lowest contour level and the increment between levels are 0.05. The grey scale is ranging from 0 to 1.

The comparison of two correlationships between the FIR emission and the ^{12}CO or ^{13}CO integrated intensity will be discussed in later section.

ii) Dust Temperature

The temperature of interstellar dust is thought to be determined by a balance between the two radiative processes. Heating occurs primarily by the absorption of stellar UV photons, and cooling by reradiation mostly in the FIR. A dust color temperature using the integrated flux density ratio at 60 and 100 μmcan be defined by using the following equation, assuming a dust emissivity law proportional to $\lambda^{-\beta}$, where β is emissivity index:

$$\frac{S_{60}}{S_{100}} = (\frac{\lambda_{60}}{\lambda_{100}})^{3+\beta} [\frac{\exp(hc/\lambda_{100}k\overline{T_d}) - 1}{\exp(hc/\lambda_{60}k\overline{T_d}) - 1}].$$

However, this expression does not include the color correction for the IRAS data. While the color corrections could be made iteratively, we have used the tabulated values provided by Lonsdale *et al.*(1985). Hildebrand (1983) estimated the emissivity index $\beta = 1$ for $\lambda = 50$ to 250 μm, and $\beta = 2$ for $\lambda > 250$ μm. Cox and Mezger (1989) assumed $\beta = 2$ for $\lambda > 100$ μm, and $\beta = 1.5$ for $\lambda = 40 - 100$ μm. The ratio of the 60 μm integrated flux density to the 100 μm integrated flux density is 0.17. The dust temperature of Lynds 1251 obtained from this ratio is 27 K when assuming a dust emissivity index of $\beta = 2$, and 29 K when $\beta = 1$. The average flux density ratio from star forming clouds is 0.53 (Carpenter, Snell, & Schloerb 1990) and corresponds to a color temperature of 37 K. A larger sample of GMCs was studied by Mooney (1992). He arbitrarily divided GMCs into two groups, IR-strong GMCs, and IR-quiet GMCs, and obtained an average dust temperature of 37 K for IR-strong clouds, and 31 K for IR-quiet clouds. Thus, the dust in Lynds 1251 is much colder than in star forming GMCs. In the two outflow regions the flux density ratios are 0.4 (IRAS 22376+7455) and 0.8 (IRAS 22343+7501), respectively. The ratios are estimated over $\sim 5'$ area centered on the two outflows. The coldest dust detected by IRAS is often associated with nearby dark clouds, and the flux density ratios found for the two Taurus clouds, B18 and Heiles Cloud 2, are 0.17 and 0.12, respectively (Snell, Heyer, and Schloerb 1989). Thus the dust color temperature of Lynds 1251 is similar to that found in the cold dark clouds.

iii) Infrared Luminosity

The total FIR flux of the cloud can be estimated from the whole portions of Lynds 1251 after subtracting the foreground and background Galactic emission. The integrated FIR flux density of the cloud is estimated to be 2,430 Jy at 100 μm, and 413 Jy at 60 μm. The total FIR luminosity $L_{IR}(tot)$ of the cloud was calculated according to the method described in the *Catalogued Galaxies and Quasars Observed in the IRAS Survey* (Lonsdale *et al.*1985) using the 60 and 100 μm integrated flux intensities. The total FIR luminosity is given by:

$$L_{IR}(tot) = 4\pi d^2 F_{IR}(tot)$$

where d is the distance to the cloud, 300 pc, and $F_{IR}(tot)$ is the total IR flux from 1 to 500 μm. The FIR flux between $\lambda = 42.4 - 122.5$ μm can be estimated by:

$$F_{IR} = 1.26 \times 10^{-26}(S_{100}\Delta\nu_{100} + S_{60}\Delta\nu_{60}) \quad [Wm^{-2}],$$

where the source flux densities are in the unit of Janskys, and IRAS 60 and 100 μm bandwidths are $\Delta\nu = 2.58 \times 10^{12}$ Hz, and $\Delta\nu = 1.0 \times 10^{12}$ Hz, respectively. The total FIR flux can then be extrapolated by assuming that the dust has a single temperature, $\overline{T_d}$. The correction factor R($\overline{T_d}, \beta$) for extrapolation is explicitly expressed as:

$$R(\overline{T_d}, \beta) = \frac{\int_{x_1}^{x_2} \frac{x^{3+\beta}}{e^x - 1} dx}{\int_{x_3}^{x_4} \frac{x^{3+\beta}}{e^x - 1} dx},$$

where $x_n = (hc/\lambda_n k\overline{T_d})$, $\lambda_1 = 1$ μm, $\lambda_2 = 500$ μm, $\lambda_3 = 42.5$ μm, and $\lambda_4 = 122.5$ μm, and we assumed $\beta = 1$.

The total FIR luminosity can now be expressed as:

$$L_{IR}(tot) = 0.394R(\overline{T_d}, \beta)(S_{100} + 2.58S_{60})D^2 \quad [L_{\odot}]$$

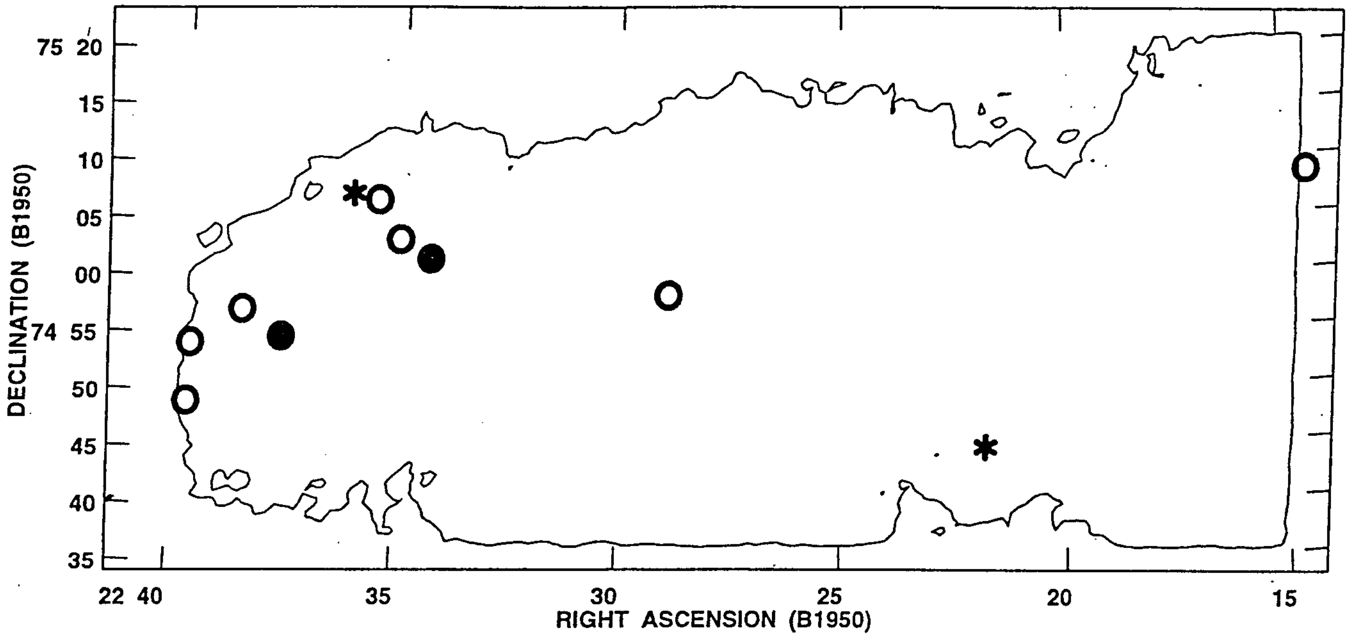

Fig. 3. IRAS point sources overlayed on the ^{12}CO integrated intensity map with a single contour at the 2 K km s^{-1} level. The asterisks mark the locations of the IRAS sources which were identified as late-type stars. The filled circles mark the location of the two IRAS sources, which are associated with outflows. The open circles are generally weak IRAS sources.

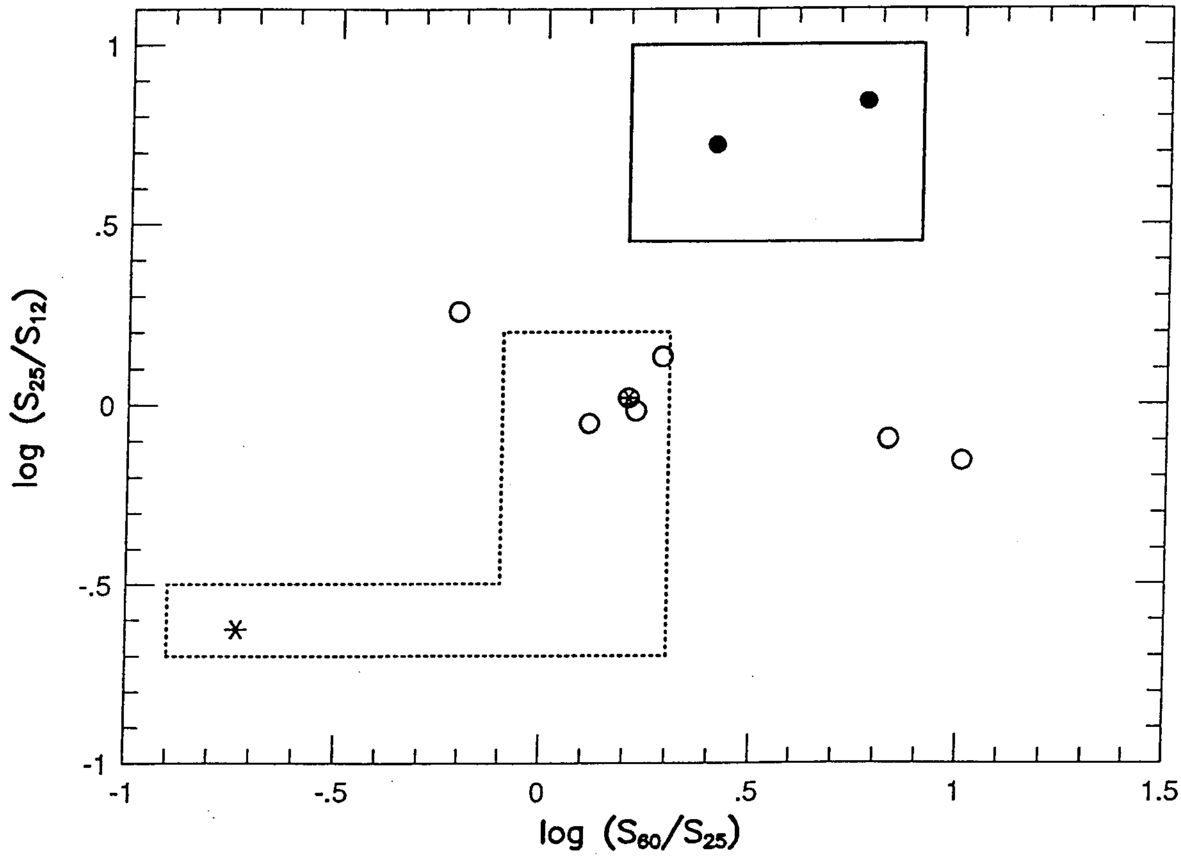

Fig. 4. Color-color diagram for the IRAS point sources of Lynds 1251. Symbols are the same as in Figure 3. The solid box indicates the location of embedded cores (Emerson 1985; Beichman et al. 1986), and the dashed box indicates the location of K stars (Lee 1996).

for D in kpc, and S_{100} and S_{60} in Janskys. Thus, the estimated IR luminosity of Lynds 1251 is 248 $L_{\odot}$. The FIR luminosity to mass ratio of 0.2 and 0.4 in solar unit (see Paper I), is much smaller than found in most star forming molecular clouds (Mooney 1992).

IV. DISCUSSION

It is one of unique features that Lynds 1251 has two prominent IRAS sources associated with outflows though it is a small dark cloud located in relatively high galactic latitude. K' band imaging (Hodapp 1994) showed striking features that stars are concentrated toward IRAS 22343+7501 and IRAS 22376+7455 and the nebulosities are associated, which imply that these are physically related, and are young, low luminosity stars recently formed in the cloud. In fact, Sato and Fukui (1989) and Sato *et al.*(1994) have confirmed bipolar molecular outflows from these IRAS sources, further strengthening the interpretation that these are young stars. These sources were also studied by Kun and Prusti (1992) focusing on Hα emission stars. They detected five of the Hα emission stars from IRAS point sources and claimed that these stars are in pre-main sequence stage. They also suggested that the IRAS sources without an optical counterpart are probably the youngest members of the stellar population in the cloud. However, the estimated infrared luminosities of these objects are much smaller than the normal value (100 $L_{\odot}$) of T Tauri stars even assuming that they are all at the same distance.

The explicit estimate of masses of these young stars may not be possible as we don't have direct information of near-infrared colors, and infrared brightness. However, based on a correlation between infrared brightness and stellar mass (Carpenter *et al.*1993), and other relating works (Lee *et al.*1996), the masses of the young stellar objects can be inferred roughly. Based on the previously published data, Lee *et al.*(1996) derived a correlation between K magnitude and mass, which can be applied to pre-main sequence. Using their relation and correcting K magnitudes for general extinction and internal extinction, the embedded stellar masses can be estimated. The internal extinction (A_K) of the embedded stars are unknown, however, A_K is usually less than 0.2 in dark cloud, and it does not affect the mass estimate significantly in this case. As the absolute magnitude of the brightest embedded stars with maximum color correction of 0.5 (Lee 1992) is $2^m.5$, the upper limit of the estimated stellar mass would be 0.3 $M_{\odot}$. Thus, the embedded stars are more or less T-Tauri stars with smaller masses than the normal T-Tauri stars. This fact is also matching with the estimate of their FIR luminosities (see above). The open circles represented in Figure 3 have not been imaged in NIR bands. These point sources have dust colors more consistent with the infrared cirrus (Weiland *et al.*1986) than known stellar objects, and thus they may simply represent fluctuations in the dust density toward Lynds 1251.

One major question to be discussed is how the dust within Lynds 1251 is heated up. The exceptionally low dust temperature of 27 K is presumably suggesting no internal heating source. Consequently, the comparison of the ratio of CO emission and infrared emission for Lynds 1251 can be discussed. Firstly, we can investigate the efficiency of the FIR emission as a tracer of the mass of Lynds 1251. The mass of radiating dust can be estimated using the expression given by Hildebrand (1983); based on the integrated flux density at 100 μm, S_{100}, and the average dust temperature, T_d, the mass of the dust is given by:

$$M_d = \frac{S_{100} d^2}{B(\nu, T_d)} \frac{4 < a > \rho}{Q_{100}} \frac{\rho}{3} \quad [M_{\odot}]$$

where d is distance of cloud, Q_{100} is emission efficiency at 100 μm, and B(ν, T_d) is Planck function. If it is assumed that the dust grains have a mean size $< a > \sim 10^{-5}$ cm, a dust density $\rho \sim 3$ gm cm^{-3}, and an emission efficiency, $Q_{100} \sim 10^{-3}$, the estimated dust mass of the cloud is ~ 1 $M_{\odot}$, or about 1/1000 of the gas mass (see Paper I). The canonical value of the dust to gas ratio by mass is $\sim 1/100$, thus the estimated small dust mass fraction implies that there must be a substantial amount of colder dust that is not emitting at IRAS wavelength bands.

Many authors have found a linear relationship between 100 μm intensity and either the H I column density in regions of atomic gas or the CO column density in molecular clouds (Boulanger & Pérault 1988; Snell, Heyer, & Schloerb, 1989). Boulanger & Pérault (1988) found ratios between the 100 μm intensity and CO integrated intensity in the range 0.6 to 2.5 (MJy/sr)/(K km s^{-1}c) with an average value of 1.4 (MJy/sr)/(K km s^{-1}c) for regions outside of star forming sites. This value can be compared with the average slope found for Lynds 1251 of 0.47 (MJy/sr)/(K km s^{-1}c), substantially less than this value. Based on the slope of the least-squares fit to the

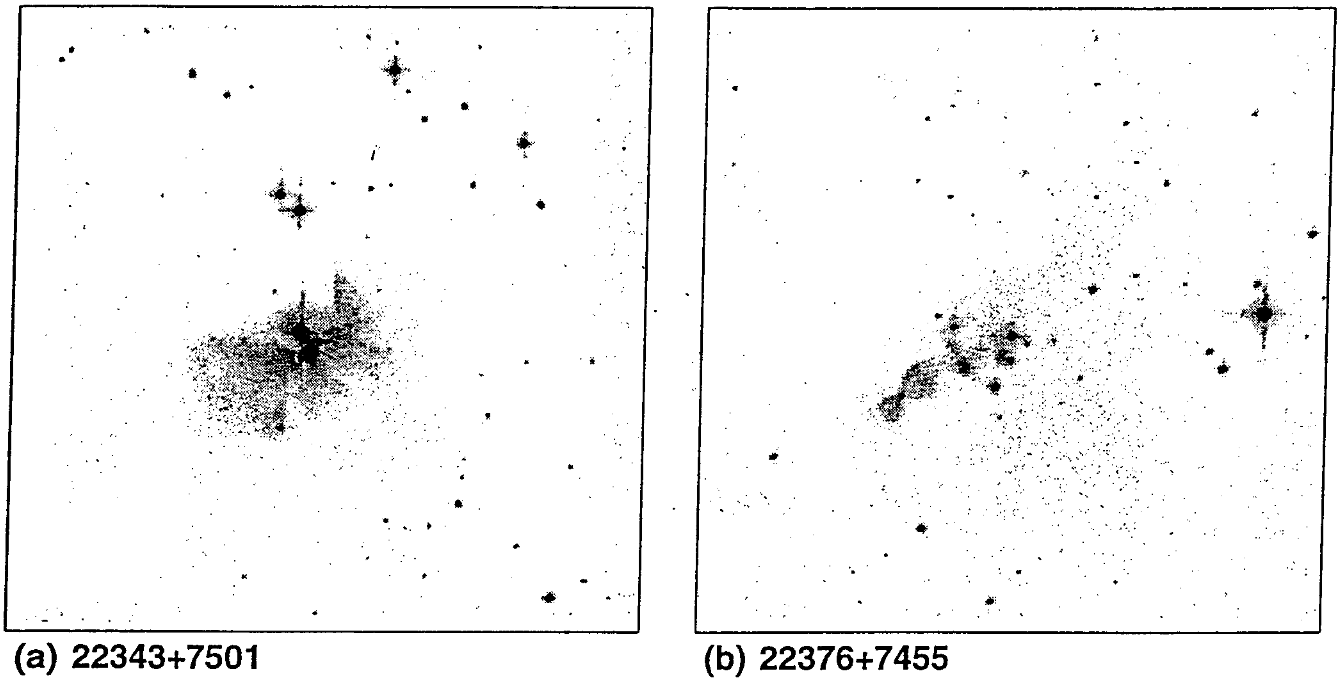

Fig. 5. K' images of IRAS sources 22343+7501 and 22376+7455.

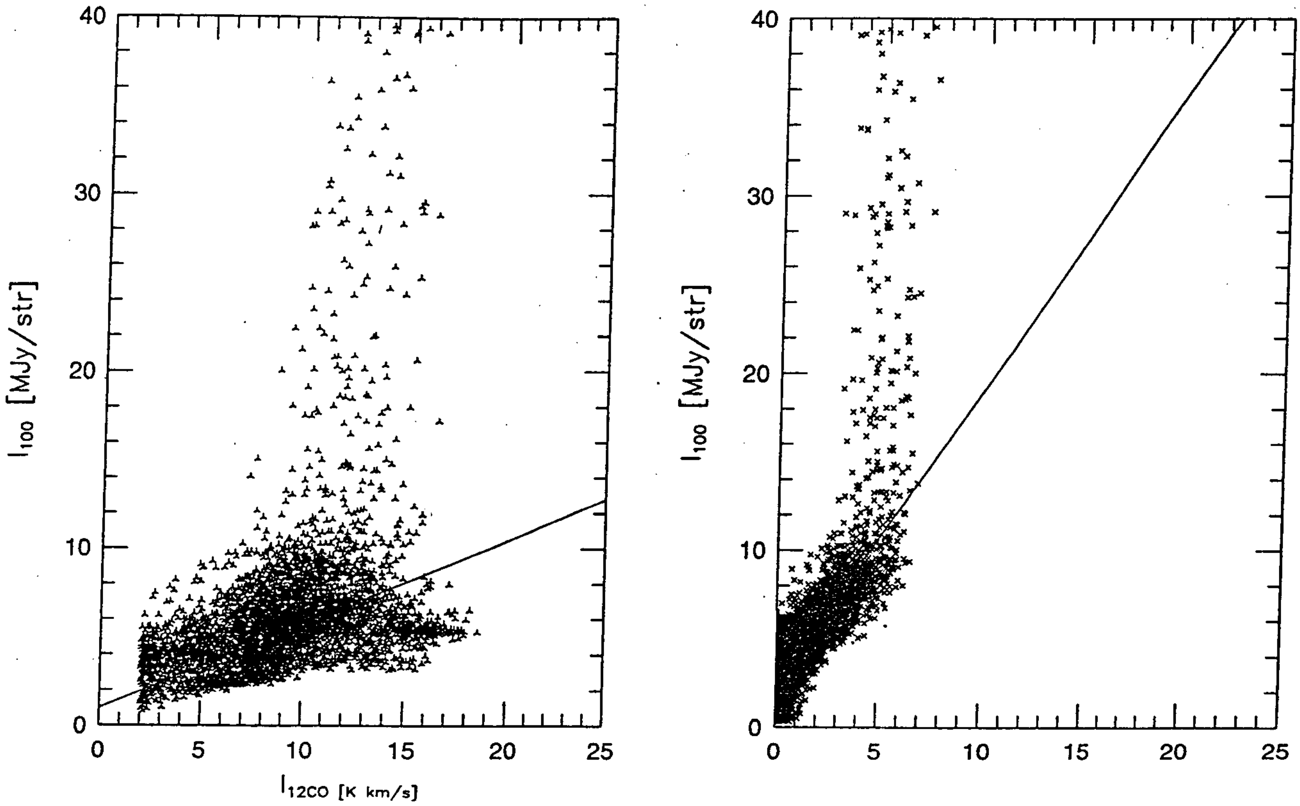

Fig. 6. The 100 μmintensity as a function of (a) I_{12CO} and (b) I_{13CO} for the whole region. Points with I_{12CO} greater than 2 K $km\ s^{-1}$ were fitted by a least squares techniques and the fitted line is shown. The points that lie substantially above the fitted line are due to two prominent IRAS point sources.

data, we have computed the ratio of 100 μm intensity to total hydrogen column density. The CO conversion factor can be computed from the γ-ray analysis (Bloemen 1989), of 2.3×10^{20} H_2 cm^{-2} (K km $s^{-1})^{-1}$ to convert the CO intensities to hydrogen column densities. Expressing this ratio in terms of the hydrogen, the values found for Lynds 1251 are $I_{100\mu m}$/N(H) = 0.08 MJy/sr (10^{20} H $cm^{-2})^{-1}$ and $I_{60\mu m}$/N(H) = 0.013 MJy/sr (10^{20} H $cm^{-2})^{-1}$. These values can be compared to those for dark clouds; $I_{100\mu m}$/N(H) is 0.07 for B18, and 0.10 for HCL2, and $I_{60\mu m}$/N(H) of both B18 and HCL2 are 0.012 MJy/sr (10^{20} H $cm^{-2})^{-1}$ (Snell, Heyer, & Schloerb 1989). The values for warmer GMCs are totally different; for example, in Orion: $I_{100\mu m}$/N(H) = 1.3 and $I_{60\mu m}$/N(H) = 0.27 MJy/sr (10^{20} H $cm^{-2})^{-1}$ (Boulanger & Pérault 1988). The ratios found for Lynds 1251 are comparable to the dark cloud ratios, and a factor of about 16 times smaller than the ratios in Orion. Snell, Heyer, & Schloerb (1989) attributed the low ratios in the dark clouds to dust heated exclusively by the solar neighborhood interstellar radiation field. A similar conclusion was reached by Mooney (1992) for the clouds he classified as IR-quiet. Thus, the unusually low ratios found for Lynds 1251 probably results from the absence of internal or significant nearby external heating sources. If this is the case, the dust temperature should also be relatively low as is seen in the dark clouds.

The correlation between I_{100} and ^{13}CO integrated intensity seems to be more tightly bound than that between I_{100} and ^{12}CO integrated intensity. This can be confirmed with Figures 1, and 2 of Paper I (Erratum: Figures were exchanged each other by editorial mistake). The correlation between I_{100} and ^{12}CO integrated intensity has clearly a larger dispersion than that between I_{100} and ^{13}CO integrated intensity. This fact may reflect that the optically thin ^{13}CO emission is more closely related to the dust emission of the cloud. The ^{13}CO peak temperature is matching well with infrared flux at 100 μm, while the ^{12}CO integrated intensity is matching with the boundary of dust emssion.

V. SUMMRY

We have studied the star forming activities and dust properties in Lynds 1251, a dark cloud located at relatively high galactic latitude with two prominent IRAS point sources. The low dust temperature and low ratio of FIR emission to hydrogen column density are probably due to the lack of internal heating sources. The dust heating is probably dominated by the interstellar heating source, and the weaker interstellar radiation field inferred by Mooney (1992) can explain the exceptionally low dust temperatures found in Lynds 1251. The estimated dust mass of Lynds 1251 is just ~ 1 $M_\odot$, or about 1/1000 of gas mass, which implies that there must be a substantial amount of colder dust. Overall, the dust properties of Lynds 1251 is similar to those of normal dark clouds even though it does have star forming activities. Presumably two low mass young stars do not have enough energy to heat up the dust and gas associated. Ten IRAS point sources were identified toward or near Lynds 1251, and groups of embedded young stars are residing in two point sources. Estimate of stellar masses, and far-infrared lumnosities imply that these are T- Tauri stars with smaller masses than 0.3 $M_\odot$. The ^{13}CO peak temperature is matching well with infrared flux at 100 μm, while the ^{12}CO integrated intensity is matching with the boundary of dust emssion.

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